14 TROUBLESHOOTING

Section **Page**

14.1 TROUBLESHOOTING THE ELECTRONIC ENGINE CONTROL SYSTEM 14-3
14.2 GENERAL TROUBLESHOOTING 14-10
14.3 FUEL INJECTION TROUBLESHOOTING 14-23
14.4 MISFIRING CYLINDER 14-47
14.5 STARTING DIFFICULTY (ENGINE ROTATES) 14-57
14.6 NO START (ENGINE WILL NOT ROTATE) 14-78
14.7 EXCESSIVE OIL CONSUMPTION 14-86
14.8 EXCESSIVE CRANKCASE PRESSURE 14-95
14.9 EXCESSIVE EXHAUST SMOKE (BLACK OR GRAY) 14-103
14.10 EXCESSIVE BLUE SMOKE 14-112
14.11 EXCESSIVE WHITE SMOKE 14-116
14.12 ROUGH RUNNING OR STALLING 14-123
14.13 LACK OF POWER 14-129
14.14 LOW OIL PRESSURE 14-145
14.15 HIGH ENGINE COOLANT TEMPERATURE 14-158
14.16 LOW COOLANT TEMPERATURE 14-173
14.17 POOR FUEL ECONOMY 14-177

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14.13 LACK OF POWER

There are several causes for lack of power. These probable causes are:

- ☐ Aerated Fuel
- ☐ High Fuel Pressure
- ☐ High Fuel Temperature Return
- ☐ Restricted Air Cleaner Element
- ☐ Restricted or Cracked Charge Air Cooler or Leaking Intake Manifold
- ☐ Faulty Exhaust System
- ☐ High Inlet Air Temperature
- ☐ Incorrect Camshaft Timing

14.13.1 Troubleshooting Procedure for Aerated Fuel

To determine if aerated fuel is causing lack of power, perform the following steps:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Test for aerated fuel.
2. Disconnect the fuel line return hose from the fitting located at the fuel tank; refer to OEM guidelines.
3. Place the open end of the fuel line into a suitable container.
4. Start and run the engine.
5. Operate the engine at 1000 rpm.
6. Visually check to see if air bubbles are rising to the surface of the fuel that collects within the container.

[a] If air bubbles are not present, shut down the engine, check for high fuel pressure; refer to section 14.13.3.

[b] If air bubbles are present, shut down the engine; refer to section 14.13.2.

14.13.2 Aerated Fuel Resolution

Perform the following steps to resolve aerated fuel condition:

1. Tighten all fuel line connections between fuel tank and fuel pump; refer to OEM guidelines.
2. Visually inspect all fuel lines between fuel tank and fuel pump for leaks.
3. Repair damaged components as required; refer to OEM guidelines.
4. Verify aerated fuel resolution; refer to section 14.13.2.1.

14.13.2.1 Test the Engine with Aerated Fuel Resolution

Perform the following steps to determine if aerated fuel resolution has resolved lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range.
3. Test drive the vehicle to ensure lack of power has been resolved.

   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.

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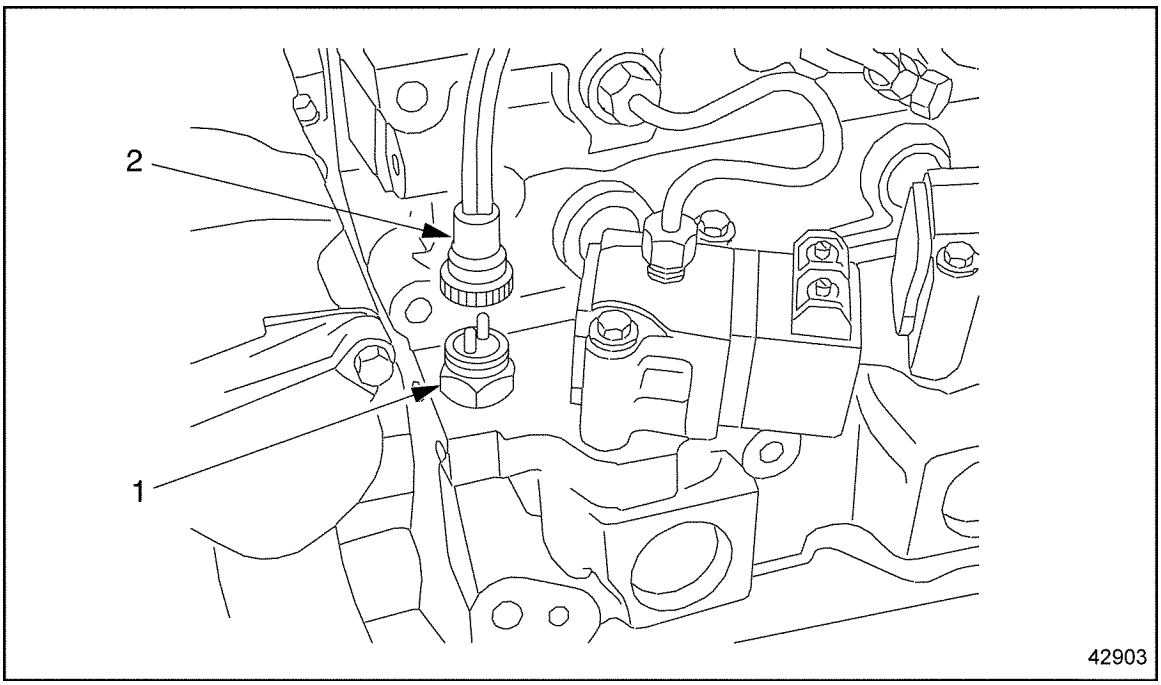
[b] If lack of power occurred during the test drive, shut down the engine. Check for high fuel pressure; refer to section 14.13.3.

14.13.3 Troubleshooting Procedure for High Fuel Pressure

To determine if high fuel pressure is causing a lack of power, perform the following steps:

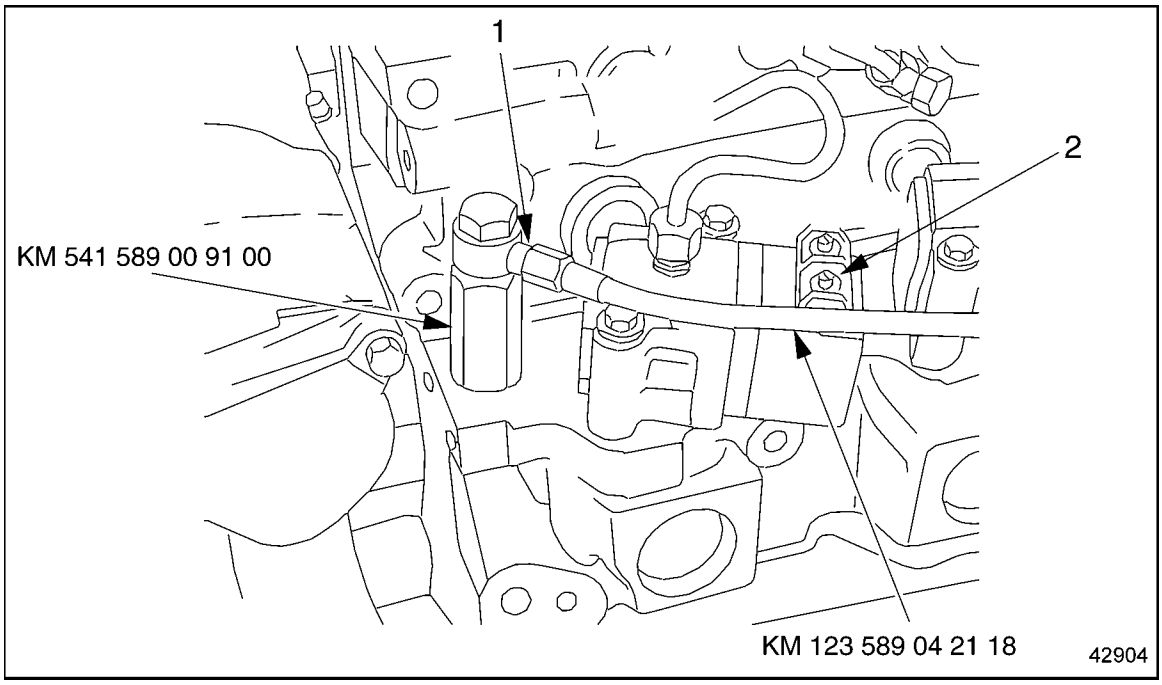
1. Remove the fuel temperature sensor. See Figure 14-19.



1. Fuel Temperature Sensor
2. Engine Wiring Harness

Figure 14-19 Disconnecting the Sensor

2. Install the adaptor (KM 541 589 00 91 00), banjo fitting, and high pressure line (KM 123 589 04 21 18). See Figure 14-20.



1. Banjo Fitting
2. Solenoid Unit Pump

Figure 14-20 Connecting the Adaptor

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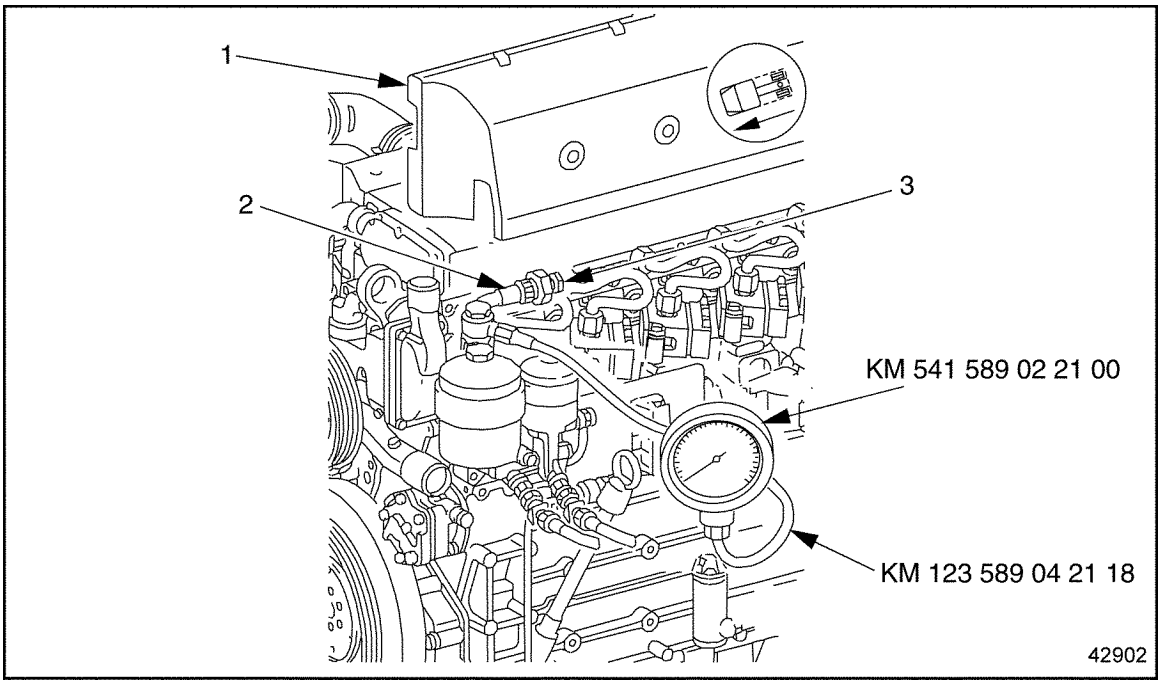
3. Attach a calibrated gauge (KM 541 589 02 21 00) capable of reading 0 - 100 lb·in.^{2}, to the high-pressure fuel line (KM 123 589 04 21 18), leading to the tee fitting. See Figure 14-21.



1. Engine Trim Panel
2. Engine Wiring Harness
3. Fuel Temperature Sensor

Figure 14-21 Attaching the Calibrated Gauge

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

4. Start and run the engine to the speeds listed in Table 14-35 and record the fuel pressure.

Engine Speed, rpm	Fuel Pressure, kPa (psi)
600-650	430 (62)
2500	400-650 (58-94)

Table 14-35 Fuel Pressure at Various Speeds

5. Shut down the engine.
6. Remove the adaptor, banjo fitting, high pressure line, and high pressure gauge.
7. Reinstall the fuel temperature sensor.
8. Analyze the measure fuel pressure readings.
   [a] If the fuel pressure is within specifications listed in Table 14-35, check for high fuel temperature return; refer to section 14.13.5.
   [b] If the fuel pressure is greater than specifications listed in Table 14-35, refer to section 14.13.4.

14.13.4 Metering Valve Replacement

Perform the following steps to replace the metering valve.

1. Remove the metering valve from the fuel return line.

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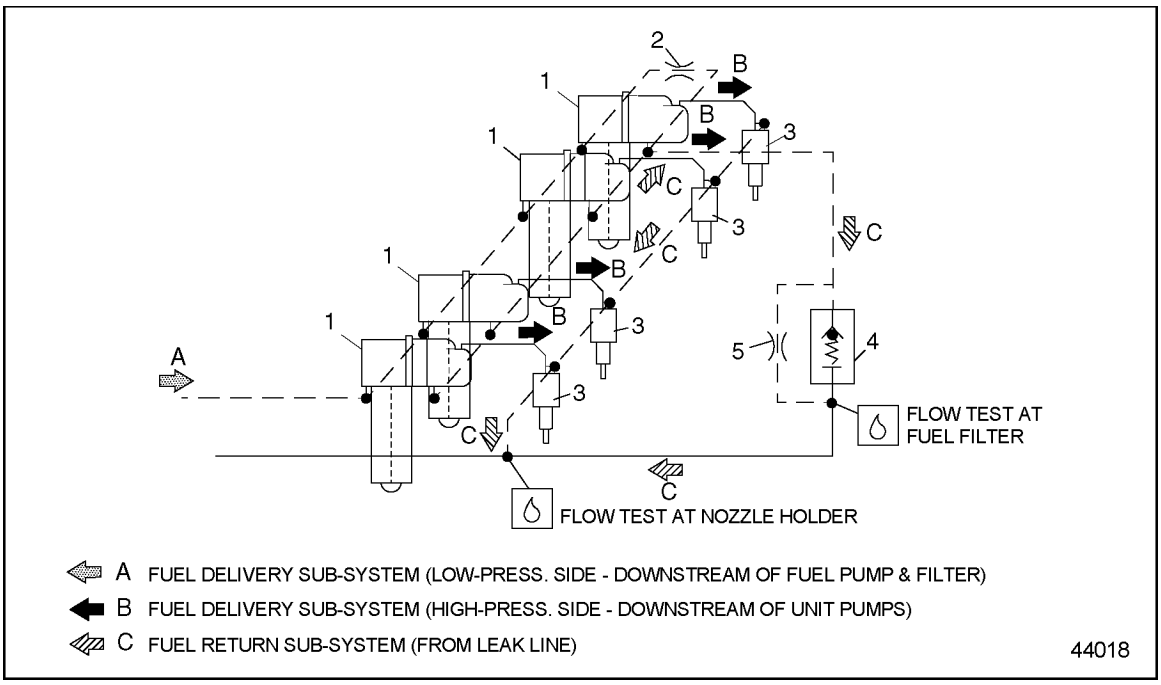
2. Install a new metering valve. See Figure 14-22.



1. Unit Pump
2. Bypass to Fuel Return Port
3. Nozzle Holder
4. Check (Overflow) Valve
5. Metering Valve

Figure 14-22 Metering Valve Location

3. Verify metering valve replacement; refer to section 14.13.4.1.

14.13.4.1 Test the Engine with Replaced Metering Valve

Perform the following steps to determine if the replaced metering valve has resolved lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range.
3. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Check for high fuel temperature return; refer to section 14.13.5.

14.13.5 Troubleshooting Procedure for High Fuel Temperature Return

To determine if high fuel temperature return is causing lack of power, perform the following steps:

1. Test for high fuel temperature return.
2. Analyze the high fuel temperature test results.
   [a] If the return fuel temperature is less than or equal to 60°C (140°F), check for air cleaner restriction; refer to section 14.13.7.
   [b] If the return fuel temperature is greater than 60°C (140°F), resolve the high fuel temperature return condition; refer to section 14.13.6.

14.13.6 High Fuel Temperature Resolution

Perform the following steps to resolve high fuel temperature return:

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1. Remove and replace fuel filter(s); refer to section 2.14.1.
2. Verify high fuel temperature repair; refer to section 14.13.6.1.

14.13.6.1 Test the Engine with Resolved High Fuel Temperature

Perform the following steps to determine if high fuel temperature repairs have resolved lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If lack of power did not occur during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of occurred during the test drive, shut down the engine. Check for a restricted air cleaner element; refer to section 14.13.7.

14.13.7 Troubleshooting Procedure for Restricted Air Cleaner Element

To determine if a restricted air cleaner element is causing lack of power, perform the following steps:

1. Remove the air filter element from the air cleaner container; refer to OEM guidelines.
2. Visually inspect the air cleaner element for damage or clogging.
   [a] If no damage or clogging is found, check the charge air cooler; refer to section 14.13.9.
   [b] If damage or clogging is found, refer to section 14.13.8.

14.13.8 Air Filter Element Replacement

Perform the following steps to replace the air filter element:

1. Remove and replace the damaged or clogged air filter element; refer to OEM guidelines.
2. Verify air filter element replacement; refer to section 14.13.8.1.

14.13.8.1 Test the Engine with Replaced Air Filter Element

Perform the following steps to determine if the new air filter element has resolved lack of power:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If lack of power did not occur during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Check the charge air cooler; refer to section 14.13.9.

14.13.9 Troubleshooting Procedure for Restricted or Cracked Charge Air Cooler or Leaking Intake Manifold

To determine if a restricted or cracked charge air cooler or leaking manifold is causing lack of power, perform the following steps:

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NOTICE:
To avoid engine damage, follow the installation instructions provided with the air-to-air charge air cooler test kit.

1. Attach a WK93 air-to-air charge air cooler test kit; refer to OEM guidelines.
2. Disconnect the air inlet hose from the outlet side of the turbocharger compressor housing; refer to section 7.4.1.
3. Attach the air-to-air cooler test kit adaptor plug to fit into the hose at the compressor connector; refer to OEM guidelines.
4. Attach an air pressure hose to the air chuck at the regulator and gradually pressurize the air inlet system to a pressure of 177 kPa (26 lb/in.^{2}).
5. Apply a water and soap solution to each hose connection, across the face of the charge air cooler.
6. Apply a water and soap solution to the air intake manifold and cylinder head mating surface area.
7. Visually inspect all joints for air leaks and all charge air cooler welded surfaces for stress leaks.
   [a] If air leaks are present around the joints, replace the charge air cooler; refer to section 14.13.10 .
   [b] If any leaks are present around the air intake manifold, replace gaskets and/or repair the air intake manifold accordingly; refer to section 14.13.11.
   [c] If neither charge air cooler nor intake manifold leaked, check the exhaust system; refer to section 14.13.12.

14.13.10 Charge Air Cooler Replacement

Perform the following steps to replace the charge air cooler:

1. Remove and replace the charge air cooler; refer to OEM guidelines.
2. If the intake manifold doesn't leak, verify replacement of the charge air cooler; refer to section 14.13.11.1.
3. If the intake manifold leaks, repair intake manifold; refer to section 14.13.11.

14.13.11 Air Intake Manifold Repair

Perform the following steps to repair the air intake manifold:

1. Remove the air intake manifold: refer to section 7.2.1.
2. Inspect the air intake manifold and gaskets.
3. Install the air intake manifold with new gaskets; refer to section 7.2.2.

4. Verify repair of the intake manifold; refer to section 14.13.11.1.

14.13.11.1 Test the Engine with Replaced Charge Air Cooler and Air Intake Manifold

To determine if the repairs resolved the lack of power condition, perform the following steps:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Check the exhaust system; refer to section 14.13.12.

14.13.12 Troubleshooting Procedure for a Faulty Exhaust System

To determine if a faulty exhaust system is causing lack of power, perform the following steps:

1. Drill an 11/32 in. hole in the exhaust pipe, 125 - 305 mm (5 - 12 in.) from the turbocharger exhaust outlet.

NOTE:
The tapped hole must be in a comparatively straight area of the turbocharger exhaust outlet.

2. Tap the hole to accommodate a 1/8 in. pipe plug.

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3. Connect a manometer to the tapped hole.

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

4. Start and run the engine.
5. Run the engine at idle with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, approximately 88-96°C (190-205°F).
6. Run the engine speed to full load.
   [a] If the exhaust back pressure at full load is less than 12 kPa (3.5 in. Hg), check for high inlet air temperature; refer to section 14.13.14.
   [b] If the exhaust back pressure at full load is 12 kPa (3.5 in. Hg) or greater, refer to section 14.13.13.

14.13.13 Engine Exhaust System Resolution

Perform the following steps to resolve the engine exhaust system concern:

1. Visually inspect the engine exhaust system; refer to OEM guidelines.
2. Repair or replace defective exhaust system components; refer to OEM guidelines.
3. Verify exhaust system resolution; refer to section 14.13.13.1.

14.13.13.1 Test the Engine with Replaced Exhaust System

Perform the following steps to determine if replaced engine exhaust system components have resolved the lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Check for high inlet air temperature; refer to section 14.13.14.

14.13.14 Troubleshooting Procedure for High Inlet Air Temperature

To determine if high inlet air temperature is causing lack of power, perform the following steps:

1. Test/check the radiator fan, fan drive, or fan shroud for proper operation or configuration; refer to OEM guidelines.
   [a] If the radiator fan, fan drive, or fan shroud pass the OEM test, check camshaft timing; refer to section 14.13.16.
   [b] If the radiator fan, drive or shroud did not operate correctly, refer to section 14.13.15.

14.13.15 Radiator Fan, Drive and Shroud Replacement

Perform the following steps to replace the radiator fan, drive, and or shroud:

1. Remove and replace the radiator fan, drive, and/or shroud; refer to OEM guidelines.
2. Verify replacement; refer to section 14.13.15.1.

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14.13.15.1 Test the Engine with Radiator Fan, Fan Drive, or Fan Shroud Replacement

Perform the following steps to determine if replaced radiator fan, fan drive, or fan shroud resolved lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Check camshaft timing; refer to section 14.13.16.

14.13.16 Troubleshooting Procedure for Incorrect Camshaft Timing

To determine if incorrect camshaft timing is causing lack of power, perform the following steps:

1. Check the camshaft timing; refer to section 1.20.1.1.
   [a] If the dial indicator reading on the unit pump lobe is 13.8 mm (0.54 in.) or above, no further troubleshooting in required.
   [b] If the dial indicator reading is not above 13.8 mm (0.54 in.), check engine timing; refer to section 14.13.17.

14.13.17 Engine Timing Resolution

Perform the following steps to resolve incorrect engine timing:

1. Perform an engine gear train timing check.
2. Verify engine timing resolution; refer to section 14.13.17.1.

14.13.17.1 Test Engine with Correct Timing

Perform the following steps to determine if corrected engine timing has resolved lack of power condition:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Test drive the vehicle to ensure lack of power has been resolved.
   [a] If no lack of power occurred during the test drive, no further troubleshooting is required. Shut down the engine.
   [b] If lack of power occurred during the test drive, shut down the engine. Call Detroit Diesel Technical Service Group.

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14.14 LOW OIL PRESSURE

There are several causes for low oil pressure. These probable causes are:

- ☐ Improper Engine Oil Level
- ☐ Improper Lubricating Oil Viscosity
- ☐ Lubricating Oil Diluted with Fuel or Engine Coolant
- ☐ Faulty Oil Pressure Gauge Sensor
- ☐ Oil Pressure Gauge Line Obstructed
- ☐ Restricted Oil Cooler
- ☐ Defective Bypass Valve
- ☐ Defective Pressure Relief Valve
- ☐ Defective Pickup Screen Tube and Screen Assembly
- ☐ Defective Crankshaft Main Bearing Shells
- ☐ Defective Oil Pump Assembly

14.14.1 Troubleshooting Procedure for Improper Engine Oil Level

To determine if improper engine oil level is causing low oil pressure, perform the following steps:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

1. Check the engine oil level. Listed in Table 14-36.

Description	4–Cylinder Engines	6–Cylinder Engines
Oil Pan Capacity*	16 L (17 qt.)	29 L (31 qt.)

* In standard pan, including oil filter.

Table 14-36 Lubricating Oil Capacity

[a] If the engine oil level is correct, check lubricating oil viscosity; refer to section 14.14.3.

[b] If the engine oil level is incorrect, refer to section 14.14.2.

14.14.2 Low Engine Oil Level Resolution

Perform the following steps for low engine oil level:

1. Fill engine oil pan to correct level listed in Table 14-36.
2. Verify low engine oil resolution; refer to section 14.14.2.1.

14.14.2.1 Test for Proper Engine Oil Level

Perform the following steps to determine if properly filled oil pan has resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and vary engine speed between 1800 - 2100 rpm.
2. Stop the engine and measure oil pressure.
   [a] If the oil pressure is correct, no further troubleshooting is required. Shut down the engine.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 psi), shut down the engine. Check lubricating oil viscosity; refer to section 14.14.3.

14.14.3 Troubleshooting Procedure for Improper Lubricating Oil Viscosity

To determine if improper lubricating oil viscosity is causing low oil pressure, perform the following steps:

1. Acquire a lubricating oil sample from the engine oil pan.
2. Submit oil sample for an ASTM test analysis.
   [a] If engine oil sample meets ASTM specifications, check to determine if lubricating oil is diluted with fuel or coolant; refer to section 14.14.5.
   [b] If engine oil sample did not meet ASTM specifications, refer to section 14.14.4.

14.14.4 Lubricating Oil Replacement

Perform the following steps to replace engine oil:

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1. Drain and refill engine with new lubricating oil listed in Table 14-36.
2. Verify lubricating oil replacement; refer to section 14.14.4.1.

14.14.4.1 Test Engine with Replaced Lubricating Oil

Perform the following steps to determine if replaced lubricating oil resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run engine speed at 1800 rpm.
2. Stop the engine and measure oil pressure.
   [a] If the oil pressure is correct, no further troubleshooting is required. Shut down the engine.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 psi), shut down the engine. Check the lubricating oil for fuel and engine coolant dilution; refer to section 14.14.5.

14.14.5 Troubleshooting Procedure for Lubricating Oil Diluted with Fuel or Engine Coolant

To determine if lubricating oil diluted with fuel or engine coolant, is causing low oil pressure, perform the following steps:

1. Acquire a lubricating oil sample from the engine oil pan.
2. Visually examine lubricating oil sample for presence of engine coolant or fuel.
   [a] If coolant or fuel are not present, check for a faulty oil pressure gauge; refer to section 14.14.7.

[b] If coolant or fuel are present, refer to section 14.14.6.

14.14.6 Contaminated Lubricating Oil Resolution

Perform the following steps to resolve contaminated lubricating oil:

1. If coolant is present, consider head gasket replacement and repair as required.
2. If fuel is present, consider fuel nozzle replacement and repair as required.
3. Drain engine oil pan.
4. Refill engine crankcase with new oil.
5. Verify lubricating oil replacement; refer to section 14.14.6.1.

14.14.6.1 Test Replaced Lubricating Oil

Perform the following steps to determine if replaced lubricating oil resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine speed at 1800 rpm.
   [a] If the oil pressure is correct, no further troubleshooting is required.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 psi), shut down the engine. Check for faulty oil pressure gauge; refer to section 14.14.7.

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14.14.7 Troubleshooting Procedure for Faulty Oil Pressure Gauge Sensor

To determine if a faulty oil pressure gauge sensor is causing low oil pressure, perform the following steps:

1. Install the Diagnostic Data Reader.

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

2. Start and vary the engine speed between 1800–2100 rpm.
3. Visually examine the DDR for oil pressure reading.
   [a] If the oil pressure is greater than or equal to 250 kPa (36 psi) at 1800 rpm, shut down the engine.
   [b] If the oil pressure is less than 250 kPa (36 psi) at 1800 rpm, shut down the engine; refer to section 14.14.8.

14.14.8 Oil Pressure Gauge Sensor Replacement

Perform the following steps to replace the oil pressure gauge sensor:

1. Remove and replace the oil pressure gauge sensor; refer to OEM guidelines.

14.14.9 Troubleshooting Procedure for Oil Pressure Gauge Line Obstructed

To determine if an oil pressure gauge line obstruction is causing low oil pressure, perform the following steps:

1. Disconnect oil gauge line from oil pressure gauge; refer to OEM guidelines.

2. Visually inspect oil gauge line for obstructions.
   [a] If no obstructions are found; check to determine if rocker arm shaft plugs are missing (new or rebuilt engines only)..
   [b] If obstructions are found, refer to section 14.14.10.

14.14.10 Obstructed Oil Pressure Gauge Line Repair

Perform the following steps to resolve oil pressure gauge line obstructions.

1. Remove oil pressure gauge line; refer to OEM guidelines.
2. Clean oil gauge line by soaking in cleaning solution for five minutes.

⚠ CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

3. Blow out oil gauge line of residue contamination with compressed air.
4. Install cleaned oil gauge line; refer to OEM guidelines.
5. Verify oil gauge line repair; refer to section 14.14.10.1.

14.14.10.1 Test the Engine with Repaired Oil Gauge Line

Perform the following steps to determine if replaced oil pressure gauge resolved low oil pressure:

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⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run engine speed at 1800 rpm.
   [a] If the oil pressure is correct, no further troubleshooting in required. Shut down the engine.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 psi), shut down the engine. Check for restricted oil cooler; refer to section 14.14.11.

14.14.11 Troubleshooting Procedure for Restricted Oil Cooler

To determine if a restricted oil cooler is causing low oil pressure, perform the following steps: Refer to section 14.14.10.1 for the two emission cautions.

1. Start and run the engine at 1800 rpm.
2. Run the engine at 1800 rpm with a no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range 88 - 96°C (190 - 205°F).
   [a] If the oil temp. sensor is indicating a lubricating oil temperature less than or equal to 110°C (230°F), shut down the engine and check for a defective bypass valve; refer to section 14.14.13.
   [b] If the oil temp. sensor is indicating a lubricating oil temperature greater than 110°C (230°F), shut down the engine and repair oil cooler; refer to section 14.14.12.

14.14.12 Oil Cooler Repair

Perform the following steps to repair the oil cooler:

1. Remove the oil cooler.

2. Clean the oil cooler before sludge hardens. Flush oil passages with clean, hot water.
3. Inspect the oil cooler for damage.
4. Install repaired oil cooler.
5. Verify repair of oil cooler; refer to section 14.14.12.1.

14.14.12.1 Test Engine with Repaired Oil Cooler

Perform the following steps to determine if oil cooler repair resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine 1800 rpm.
2. Run the engine through its operating range with no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range, 88 - 96°C (190 - 205°F).
   [a] If the DDR indicates 241 kPa (35 lb/in.^{2}) or more at 1800 rpm, shut down the engine and disconnect the DDR. No further troubleshooting is required.
   [b] If the DDR indicates less than 241 kPa (35 lb/in.^{2}) or more at 1800 rpm, shut down the engine and disconnect the DDR. Check for defective bypass valve; refer to section 14.14.13.

14.14.13 Troubleshooting Procedure for Defective Bypass Valve

To determine if a defective bypass valve is causing low oil pressure, perform the following steps:

1. Remove the oil pressure/temperature sensor.

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2. Inspect the oil filter bypass valve components.
   [a] If no damage is found with the oil filter housing bypass valve components, check for defective pressure relief valve; refer to section 14.14.14.
   [b] If damage is found with the oil filter housing bypass valve bore, replace housing.

14.14.14 Troubleshooting Procedure for Defective Pressure Relief Valve

To determine if a defective pressure relief valve is causing low oil pressure, perform the following steps:

1. Remove the pressure relief valve.
2. Inspect the oil pressure relief valve.
   [a] If the relief valve moves freely in the valve body, reinstall the oil pressure relief valve. Check the pickup tube and screen assembly for defects; .
   [b] If the relief valve will not move freely in the valve body, refer to section 14.14.15.

14.14.15 Pressure Relief Valve Repair

Perform the following steps to repair the pressure relief valve:

1. Disassemble the pressure relief valve and replace damaged components.
2. Assemble and install the pressure relief valve.
3. Verify repair of the relief valve; refer to section 14.14.15.1.

14.14.15.1 Test Engine with Repaired Relief Valve

Perform the following steps to determine if repaired relief valve resolved low oil pressure:

1. Install the Diagnostic Data Reader.

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

2. Start and run engine speed at 1800 rpm.
3. Visually examine the DDR for oil pressure reading.
   [a] If the DDR indicates 241 kPa (35 lb/in.^{2}) or more at 1800 rpm, shut down the engine and disconnect the DDR. No further troubleshooting is required.
   [b] If the DDR indicates less than 241 kPa (35 lb/in.^{2}) at 1800 rpm, shut down the engine and disconnect the DDR. Check for defective pickup tube and screen assembly; refer to section 14.14.16.

14.14.16 Troubleshooting Procedure for Defective Pickup Screen Tube and Screen Assembly

To determine if a defective pickup screen tube or screen assembly is causing low oil pressure, perform the following steps:

1. Remove pickup screen tube and screen assembly.
2. Visually inspect pickup screen tube and screen assembly.
   [a] If no tube stress cracks, twisted screen tube, or cracked flange gaskets are found, check for defective crankshaft main bearing shells; refer to section 14.14.18.
   [b] If stress cracks, twisted screen tube, or cracked flange gaskets are found, refer to section 14.14.17.

14.14.17 Pickup Screen Tube and Screen Assembly Repair

Perform the following steps to repair the pickup screen tube and screen assembly:

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1. Replace all damaged components identified during inspection and install.
2. Verify repairs to pickup screen tube and screen assembly; refer to section 14.14.17.1.

14.14.17.1 Test Engine with Repaired Pickup Screen Tube and Screen Assembly

Perform the following steps to determine if repaired relief valve resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine speed at 1800 rpm.
2. Visually examine oil pressure reading.
   [a] If the oil pressure is correct, no further troubleshooting is required.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 lb/in.^{2}), check for defective crankshaft main bearing shells; refer to section 14.14.18.

14.14.18 Troubleshooting Procedure for Defective Crankshaft Main Bearing Shells

To determine if defective crankshaft main bearing shells are causing low oil pressure, perform the following steps:

1. Check main bearing to crankshaft journal clearances; .
   [a] If main bearing shell-to-journal clearance is within 0.051-0.127 mm (0.002-0.005 in.), check for defective oil pump assembly; refer to section 14.14.20.
   [b] If main bearing shell-to-journal clearance is not within 0.051-0.127 mm (0.002-0.005 in.), refer to section 14.14.19.

14.14.19 Crankshaft Main Bearing Shell Repair

Perform the following steps to repair crankshaft main bearing shells:

1. Remove and replace defective crankshaft main bearing shells.
2. Verify crankshaft main bearing shells repair; refer to section 14.14.19.1.

14.14.19.1 Test Engine with New Crankshaft Main Bearing Shells

Perform the following steps to determine if new crankshaft main bearing shells have resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run engine speed to 1800 rpm.
2. Visually examine the oil pressure reading.
   [a] If the oil pressure is correct, no further troubleshooting is required. Shut down the engine.
   [b] If the oil pressure at rated speed is less than 250 kPa (36 lb/in.^{2}), shut down the engine. Check the oil pump assembly; refer to section 14.14.20.

14.14.20 Troubleshooting Procedure for Defective Oil Pump Assembly

To determine if a defective oil pump is causing low oil pressure, perform the following steps:

1. Remove the oil pump assembly; refer to section 4.3.1.
2. Manually rotate the oil pump drive gear.

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[a] If the drive gear rotates freely in the pump housing, call Detroit Diesel Technical Service Group.

[b] If the drive gear did not rotate freely, replace the oil pump assembly and verify repair; refer to section 14.14.20.1.

14.14.20.1 Test Engine with Replaced Oil Pump Assembly

Perform the following steps to determine if oil pump replacement resolved low oil pressure:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine speed at 1800 rpm.
2. Visually examine the oil pressure reading.

   [a] If the oil pressure is correct, no further troubleshooting is required. Shut down the engine.

   [b] If the oil pressure at rated speed is less than 250 kPa (36 lb/in.^{2}), shut down the engine and call Detroit Diesel Technical Service Group.

14.15 HIGH ENGINE COOLANT TEMPERATURE

There are several causes for high engine coolant temperature. These probable causes are:

- ☐ Improper Engine Coolant Level
- ☐ Insufficient Radiator Air Circulation
- ☐ Faulty Pressure Control Cap
- ☐ Defective Coolant Hoses
- ☐ Fan Belt is Incorrectly Adjusted
- ☐ Inoperative Thermo-Modulated Fan
- ☐ Faulty Thermostats
- ☐ Faulty Water Pump
- ☐ Combustion Gases in Coolant
- ☐ Abnormal Radiator Coolant Flow

14.15.1 Troubleshooting Procedure for Improper Engine Coolant Level

To determine if improper engine coolant level is causing high engine coolant temperature, perform the following:

1. Visually inspect the radiator coolant level; refer to OEM guidelines.
   [a] If the radiator coolant level is within approximately 50 mm (2.0 in.) of the radiator filler neck, check for insufficient radiator air circulation; refer to section 14.15.3.
   [b] If the radiator coolant level is not within approximately 50 mm (2.0 in.) of the radiator filler neck, refer to section 14.15.2.

14.15.2 Improper Coolant Level Resolution

Perform the following steps to resolve improper coolant level:

⚠ CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

1. Fill coolant system to correct level; refer to section 5.1.1.
2. Verify coolant level resolution; refer to section 14.15.2.1.

14.15.2.1 Test Engine with Proper Coolant Level

Perform the following to determine if proper coolant level resolved high engine coolant temperature:

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⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.

   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.

   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check for insufficient radiator air circulation; refer to section 14.15.3.

14.15.3 Troubleshooting Procedure for Insufficient Radiator Air Circulation

To determine if insufficient radiator air circulation is causing high engine coolant temperature, perform the following:

1. Visually examine the radiator and radiator shrouding.

   [a] If the radiator is absent of clogging, debris, and dirt, check the pressure control cap; refer to section 14.15.6.

   [b] If the radiator has excessive clogging, debris, or dirt; refer to section 14.15.4.

   [c] If the radiator shrouding is not damaged, incorrectly positioned, or inadequate, check the pressure control cap; refer to section 14.15.6.

   [d] If the radiator shrouding is damaged, incorrectly positioned, or inadequate, refer to section 14.15.5.

14.15.4 Exterior Radiator Repair

Perform the following for exterior radiator repair:

1. Clean the exterior radiator of all clogging, debris, or excessive dirt; refer to OEM guidelines.
2. Verify exterior radiator repair; refer to section 14.15.5.1.

14.15.5 Radiator Shroud Repair

Perform the following for radiator shroud repair:

1. Repair or replace damaged radiator shrouding; refer to OEM guidelines.
2. Verify exterior radiator repair; refer to section 14.15.5.1.

14.15.5.1 Test Engine with Repaired Exterior Radiator and Shrouding

Perform the following to determine if exterior radiator and shrouding repair resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.

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[b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check the pressure control cap; refer to section 14.15.6.

14.15.6 Troubleshooting Procedure for Faulty Pressure Control Cap

To determine if a faulty pressure control cap is causing high engine coolant temperature, perform the following:

1. Perform coolant pressure control cap tests.
   [a] If the cooling system pressure is less than or equal to 62 kPa (9 lb/in²), check the coolant hoses; refer to section 14.15.8.
   [b] If the cooling system pressure is greater than 62 kPa (9 lb/in²), refer to section 14.15.7.

14.15.7 Pressure Control Cap Resolution

Perform the following steps to resolve faulty pressure control cap:

⚠ CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

1. Remove and replace pressure control cap; refer to OEM guidelines.
2. Install a new pressure control cap; refer to OEM guidelines.
3. Verify pressure control cap repair; refer to section 14.15.7.1.

14.15.7.1 Test Engine with Replaced Pressure Control Cap

Perform the following to determine if exterior radiator repair resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is normal, no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not normal, shut down the engine. Check coolant hoses; refer to section 14.15.8.

14.15.8 Troubleshooting Procedure for Defective Coolant Hoses

To determine if defective coolant hoses are causing high engine coolant temperature, perform the following:

1. Visually examine cooling system hoses; refer to OEM guidelines.
   [a] If cooling system hoses are not soft, deteriorated, collapsed, or have leaking connections, check the fan belts; refer to section 14.15.10.
   [b] If cooling system hoses are soft, deteriorated, collapsed, or have leaking connections, refer to section 14.15.9.

14.15.9 Coolant System Hoses Replacement

Perform the following steps to resolve worn or damaged coolant system hoses:

1. Remove and replace damaged or worn coolant hoses as necessary; refer to OEM guidelines.

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2. Install new coolant hoses as necessary; refer to OEM guidelines.
3. Verify replaced coolant system hoses; refer to section 14.15.9.1.

14.15.9.1 Test Engine with Replaced Coolant Hoses

Perform the following to determine if the new coolant hoses resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range, and visually examine replaced hoses for any leaks.
   [a] If the engine coolant temperature is 82-105°C (180-221°F) and no leaks are found, no further troubleshooting is required.
   [b] If the engine coolant temperature is 82-105°C (180-221°F) and leaks are found, repair the leaks; refer to section 14.15.9. Shut down the engine.
   [c] If the engine coolant temperature is not 82-105°C (180-221°F) and no leaks are found, shut down the engine. Check fan belt; refer to section 14.15.10.

14.15.10 Troubleshooting Procedure for Fan Belt is Incorrectly Adjusted

To determine is a misadjusted fan belt is causing high engine coolant temperature, perform the following:

1. Check the auto tensioner for spring loading.

2. Compare tension to belt specifications.
   [a] If the belt tension is normal, check the thermo-modulated fan; refer to section 14.15.12.
   [b] If the belt tension is not normal, refer to section 14.15.11.

14.15.11 Belt Tension Resolution

Perform the following steps to resolve incorrect belt tension:

⚠ CAUTION:

To avoid injury from flying parts when working with components under spring tension, wear adequate eye protection (face shield or safety goggles).

⚠ CAUTION:

To avoid injury to hands and fingers from the spring-loaded auto belt tensioner violently snapping back, do not cut the belt to remove it.

1. Replace the auto tensioner as required.
2. Verify belt tension resolution; refer to section 14.15.11.1.

14.15.11.1 Test Engine with Correct Belt Tension

Perform the following to determine if belt tension resolved high engine coolant temperature:

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⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check thermo-modulated fan; refer to section 14.15.12.

14.15.12 Troubleshooting Procedure for Inoperative Thermo-Modulated Fan

To determine if an inoperative thermo-modulated fan is causing high engine coolant temperature, perform the following:

1. Test the thermo-modulated fan; refer to OEM guidelines.
   [a] If the thermo-modulated fan is functioning correctly, check thermostats; refer to section 14.15.14.
   [b] If the thermo-modulated fan is not functioning correctly, refer to section 14.15.13.

14.15.13 Thermo-moduluated Fan Replacement

Perform the following steps to replace inoperative thermo-modulated fan:

1. Replace inoperative thermo-modulated fan; refer to OEM guidelines.
2. Verify thermo-modulated fan replacement; refer to section 14.15.13.1.

14.15.13.1 Test Engine with Replaced Thermo-modulated Fan

Perform the following steps to determine if thermo-modulated fan replacement resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C 180-221°F(), no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check thermostats; refer to section 14.15.14.

14.15.14 Troubleshooting Procedures for Faulty Thermostats

To determine if faulty thermostats are causing high engine coolant temperature, perform the following:

1. Remove thermostat from the thermostat housing; refer to section 5.4.1.
2. Inspect thermostat for correct operation; refer to section 5.4.1.1.
   [a] If thermostat is fully open at 95°C (203°F), check water pump; refer to section 14.15.16.
   [b] If thermostat is not fully open at 95°C (203°F), refer to section 14.15.15.

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14.15.15 Thermostat Replacement

Perform the following steps to replace thermostats:

1. Install new thermostat; refer to section 5.4.2.
2. Verify replaced thermostat; refer to section 14.15.15.1.

14.15.15.1 Test Engine with New Thermostat

Perform the following steps to determine if thermostat replacement resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.

   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.

   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check water pump; refer to section 14.15.16.

14.15.16 Troubleshooting Procedure for Faulty Water Pump

To determine if a faulty water pump is causing high engine coolant temperature, perform the following:

1. Remove the water pump and inspect pump for failed shaft or rotor.

2. Replace water pump if damaged.

14.15.16.1 Test Engine with Replaced Water Pump

Perform the following steps to determine if thermo-modulated fan replacement resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check combustion gases in coolant; refer to section 14.15.17.

14.15.17 Troubleshooting Procedure for Combustion Gases in Coolant

To determine if combustion gases in coolant is causing high engine coolant temperature, perform the following:

1. Perform a cylinder compression test.
   [a] If test results are to specifications; check radiator coolant flow; refer to section 14.15.19.
   [b] If test results are not to specifications, refer to section 14.15.18.

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14.15.18 Cylinder Head Gasket Replacement

Perform the following steps to replace cylinder head gasket:

1. Remove and replace cylinder head gasket; refer to section 1.2.2.
2. Verify new cylinder head gasket replacement; refer to section 14.15.18.1.

14.15.18.1 Test Engine with Replaced Cylinder Head Gasket

Perform the following to determine if cylinder head gasket replacement resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check radiator coolant flow; refer to section 14.15.19.

14.15.19 Troubleshooting Procedure for Abnormal Radiator Coolant Flow

To determine if abnormal radiator coolant flow is causing high engine coolant temperature, perform the following:

1. Install a sight glass with string (both ends) to the radiator outlet hose near radiator and before fill and heater return lines; see Figure 14-23.

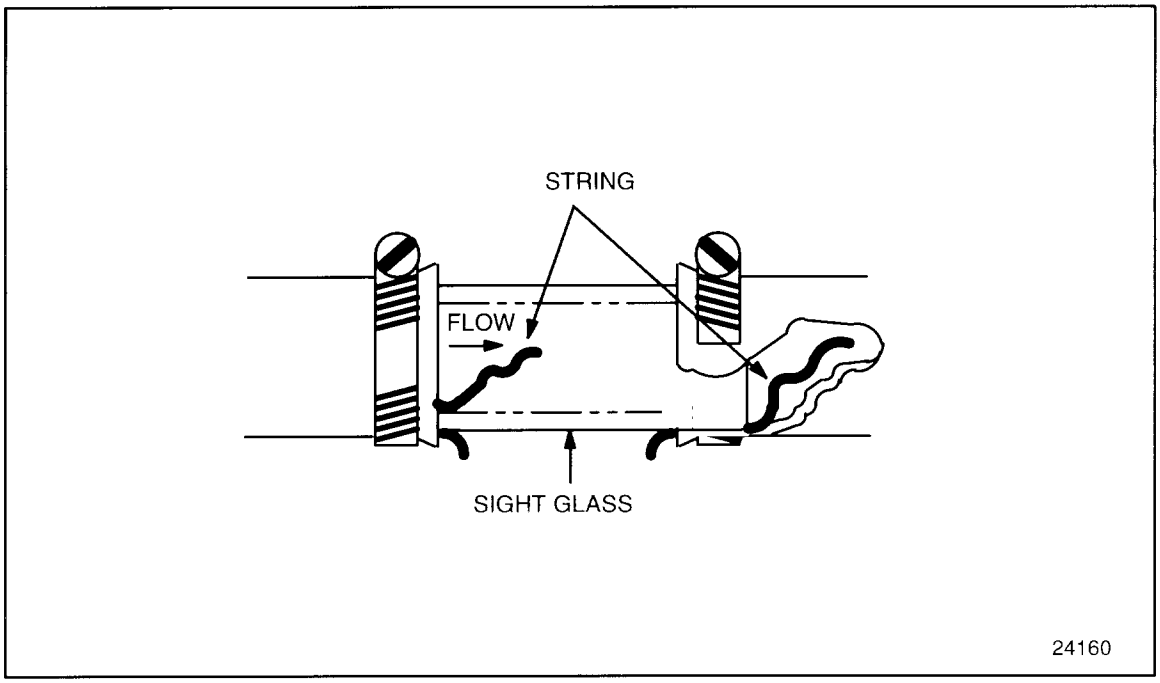

Figure 14-23 Radiator Flow Check

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⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- ☐ **Always start and operate an engine in a well ventilated area.**
- ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- ☐ **Do not modify or tamper with the exhaust system or emission control system.**

2. Start and run the engine at full load.
3. Observe the string for flow and direction as well as the fill and bleed lines. Continue observation while varying the engine speed between 1800-2400 rpm.
   [a] If a balanced coolant flow is observed in the sight glass, call Detroit Diesel Technical Service Group. Shut down the engine.
   [b] If a balanced coolant flow is not observed in the sight glass, refer to section 14.15.20. Shut down the engine.

14.15.20 Abnormal Radiator Coolant Flow Resolution

Perform the following steps, as necessary, to resolve abnormal radiator coolant flow:

1. Correct bleed line size, refer to OEM guidelines.
2. Correct fill line size or connector fitting size; refer to OEM guidelines.
3. Correct restrictive top tank opening; refer to OEM guidelines.
4. Correct location of standpipe; refer to OEM guidelines.
5. Verify repairs made to correct abnormal radiator coolant flow; refer to section 14.15.20.1.

14.15.20.1 Test Engine with Resolved Radiator Coolant Flow

Perform the following to determine if thermo-modulated fan replacement resolved high engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.

   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.

   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Call the Detroit Diesel Technical Service Group.

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14.16 LOW COOLANT TEMPERATURE

There are several causes for low coolant temperature. These probable causes are:

- ☐ Faulty Thermostats
- ☐ Insufficient Radiator Air Circulation

14.16.1 Troubleshooting Procedure for Faulty Thermostats

To determine if faulty thermostats are causing low engine coolant temperature, perform the following steps:

1. Remove thermostat from the thermostat housing; refer to section 5.4.1.
2. Inspect thermostat for correct operation; refer to section 5.4.1.1.
   [a] If the thermostat is fully open at 95°C (203°F), check insufficient radiator air circulation; refer to section 14.16.3.
   [b] If the thermostat is not fully open at 95°C (203°F), refer to section 14.16.2.

14.16.2 Thermostat Replacement

Perform the following steps to replace thermostats:

1. Install new thermostat; refer to section 5.4.2.
2. Verify replaced thermostat; refer to section 14.16.2.1.

14.16.2.1 Test Engine with New Thermostat

Perform the following steps to determine if thermostat replacement resolved low engine coolant temperature:

⚠ CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

⚠ CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **☐ Always start and operate an engine in a well ventilated area.**
- **☐ If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **☐ Do not modify or tamper with the exhaust system or emission control system.**

⚠ CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

1. Start and run the engine.
2. Run the engine through its operating range with no-load for approximately five minutes, allowing the engine coolant to reach normal operating range.
   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.
   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Check insufficient radiator air circulation; refer to section 14.16.3.

14.16.3 Troubleshooting Procedure for Insufficient Radiator Air Circulation

To determine if insufficient radiator air circulation is causing low engine coolant temperature, perform the following:

1. Visually examine the radiator and radiator shrouding.
   [a] If the radiator has excessive clogging, debris, or dirt, refer to section 14.16.4.

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[b] If the radiator shrouding is not damaged, incorrectly positioned, or inadequate, and if the radiator is absent of clogging, debris, and dirt, then call Detroit Diesel Technical Service Group.

[c] If the radiator shrouding is damaged, incorrectly positioned, or inadequate, refer to section 14.16.5.

14.16.4 Exterior Radiator Repair

Perform the following steps for exterior radiator repair:

1. Clean the exterior radiator of all clogging, debris, or excessive dirt; refer to OEM guidelines.
2. Verify exterior radiator repair; refer to section 14.16.5.1.

14.16.5 Radiator Shroud Repair

Perform the following steps for radiator shroud repair:

1. Repair or replace damaged radiator shrouding; refer to OEM guidelines.
2. Verify exterior radiator repair; refer to section 14.16.5.1.

14.16.5.1 Test Engine with Repaired Exterior Radiator and Shrouding

CAUTION:

To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

1. Start and run the engine.
2. Run the engine through its operating range with no-load condition for approximately five minutes, allowing the engine coolant to reach normal operating range.

   [a] If the engine coolant temperature is 82-105°C (180-221°F), no further troubleshooting is required. Shut down the engine.

   [b] If the engine coolant temperature is not 82-105°C (180-221°F), shut down the engine. Call Detroit Diesel Technical Service Group.

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14.17 POOR FUEL ECONOMY

Customer expectations of fuel economy are usually based on past experiences, recommendations from colleagues or sales staff, and wishful thinking. It is paramount that the end user attain reasonable expectations, based on sound predictions. This can be accomplished with the aid of Detroit Diesel's Spec Manager® computer program. The program takes into consideration a number of factors such as vehicle design, duty cycle, and route profile as it predicts real world fuel economy. Contact the local Detroit Diesel distributor for Spec Manager support, prior to contacting the factory. Make sure that there is sound basis for the poor fuel economy complaint. This applies to both new and in-service vehicles.

There are many variables which may affect fuel economy. Included are:

- ☐ Vehicle Frontal Area
- ☐ Vehicle Weight
- ☐ Rolling Resistance (Static and rolling)
- ☐ Air Resistance (Excessive add-ons increase air resistance; trailer gap too large)
- ☐ Engine Speed
- ☐ Tire Size (Revs/mile)
- ☐ Axle Ratio
- ☐ Transmission Gear Ratios
- ☐ Road Surface (Cement, blacktop, gravel)
- ☐ Duty Schedule (Highway, stop-and-go, excessive idling)
- ☐ Vehicle Maintenance (Plugged air filter, low tire pressure, poor wheel alignment, brakes dragging)
- ☐ Vehicle Cruise Speed
- ☐ Driver Habits
- ☐ Weather Conditions

NOTE:
If any of these variables is not optimized, a serious penalty in fuel economy will result. Many of these items are out of the operator's control. However, there are factors that can be controlled, and have a major impact on fuel economy.

14.17.1 Troubleshooting Guidelines for Vehicle Cruise Speed

One of the most common factors that reduces fuel economy is vehicle cruise speed. Perform the following step to help increase fuel economy:

1. Maintain cruising speed as low as possible. Listed in Table 14-37 are the approximate percentages of fuel economy reduction based on vehicle cruising speed.

Vehicle Cruise Speed (mph)	Approximate Reduction in Fuel Economy (%)
50–51	2
51–52	3
52–53	4
53–54	5
54–55	10
55–65	10
75	20

Table 14-37 Fuel Economy Reduction based on Cruising Speed

14.17.2 Troubleshooting Guidelines for Excessive Engine Idling

Another factor to consider is excessive engine idling. Aside from the fact that the operator is getting 0 mpg during idling, combustion is less than ideal. This can compromise the efficiency of the turbocharger. Regarding the notion that idling maintains cab heat in the winter, some tests have shown that during the first hour after full load operation, the engine actually cools down at a faster rate when idling than when turned off. Therefore, perform the following step to increase fuel economy:

1. Minimize engine idling.

14.17.3 Troubleshooting Guidelines for Fuel Economy in Cold Weather

It is not uncommon to experience a loss in fuel economy during the winter. Cold, ambient conditions bring on more engine idling, increased resistance in moving parts such as engine, transmission, and axle, due to fluid viscosity increase. There is also the issue of winter-blended fuel. Blended fuel typically does not contain as much energy as summer fuel. Therefore, it takes more fuel to move the equipment. Tests have shown that there can be as much as a 7% penalty in fuel economy due to blended fuels. Therefore, perform the following step to save on fuel economy:

1. Fuel economy comparisons must be made for the same yearly time frame.

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